Novel rapidity dependence of directed flow in high energy heavy ion collisions[1]

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The collective expansion of the system created during a heavy-ion collision implies space-momentum correlation in particle distributions at freeze-out. Simplified, this means that particles created on the left side of the system move in the left direction and particles created on the right side move in the right direction (on average). We will show that the rapidity dependence of directed flow of nucleons and pions can address this space-momentum correlation experimentally.

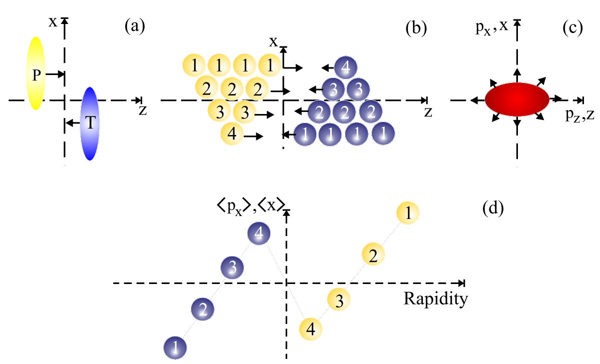

Figure 1: A schematic sketch of a medium central symmetric heavy-ion collision in progressing time (a),(c) and the rapidity distribution of $\langle p_x \rangle$ and $\langle x \rangle$ in (d). In (b) the overlap region is magnified and the "spectators" are not shown In these figures x is the coordinate along the impact parameter direction and z is the coordinate along the projectile direction (for a more detailed description see text).

A sketch of a medium central symmetric heavy-ion collision is shown in Fig. 1, from before the collision (a,b) to the resulting distributions of $\langle x \rangle$ and $\langle p_x \rangle$ shown in (d). In Fig. 1a the projectile and target are shown before the collision in coordinate space. In Fig. 1b the overlap region is magnified and the "spectators" are not shown. It shows in a schematic way the number of nucleons and their position in the x–z plane (where $\hat{\mathbf{x}}$ is the impact parameter direction). Projectile nucleons (light color) at negative x suffer more rapidity loss than those at positive x, ending up closer to mid-rapidity. Assuming a positive space-momentum correlation (as indicated in Fig. 1c), these nucleons have negative $\langle p_x \rangle$, while those at positive x have positive $\langle p_x \rangle$. This results in a wiggle structure in the rapidity dependencies of $\langle x \rangle$ and $\langle p_x \rangle$ which is shown schematically in Fig. 1d.

The shape of the wiggle, both the magnitude of $\langle p_x \rangle$ and the rapidity range, depends on the beam energy, the amount of stopping and the strength of the space-momentum correlation. Therefore, the dependence of the wiggle on the collision centrality, system size and center of mass energy may reveal important information on the equation of state. This has been shown in realistic model calculations [1, 2].

References

[1] R.J.M Snellings, H. Sorge, S.A. Voloshin, F.Q. Wang and N. Xu, nucl-th/9908001; Accepted for Physics Review Letters.

[2] H. Sorge, nucl-th/9905008.